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The Effect of Recurrent Selection of Lint Percentage in an Interspecific Hybrid of Cotton.

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THE EFFECT OF RECURRENT SELECTION OF LINT
PERCENTAGE IN AN INTERSPECIFIC HYBRID OF
COTTON.**

**Louisiana State University and Agricultural and Mechanical
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Agronomy**

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THE EFFECT OF RECURRENT SELECTION ON LINT PERCENTAGE
IN AN INTERSPECIFIC HYBRID OF COTTON

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
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requirements for the degree of
Doctor of Philosophy

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by

Warren Allen Meadows
B.S., Louisiana State University, 1955
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ABSTRACT

This study was conducted to determine the effect of the first cycle of recurrent selection on lint percentage in an interspecific hybrid of cotton involving strains of Deltapine 15 (Gossypium hirsutum) and Sea Island (G. barbadense). The Deltapine 15 original parent was high in lint percentage and the Sea Island original parent was low in lint percentage.

An F_2 population of 372 plants was grown and evaluated on the basis of several characters including lint percentage and fiber strength. F_3 lines were grown from 51 selected F_2 plants and evaluated on the basis of lint percentage, fiber strength, boll size and earliness. On the basis of these data eight F_3 lines, each apparently superior in respect to one or more of these characters, were selected to serve as intercross parents for the first cycle of recurrent selection.

These eight F_3 lines were regrown from remnant seed the following year and intercrosses were attempted in all possible combinations. Eight individual plants were selected at random within each of the eight F_3 lines to serve as intercross parent plants within lines.

Materials used in this study included the original parents, F_4 progenies of individual F_3 plants involved as intercross parents and 20 of the 28 possible intercross populations composing the first cycle recurrent selection population.

For convenience, all hybrid plants derived from the various crosses between two F_3 lines were designated as an intercross population and the hybrid plants derived from a cross between two specific F_3 plants were designated as an intercross progeny. Thus, each intercross population would normally contain several intercross progenies.

The first cycle recurrent selection population was composed of a total of 1,005 individual plants, 20 intercross populations and 76 intercross progenies which contained 6 or more plants each.

The mean lint percentage of the entire first cycle recurrent selection population (33.8%) was essentially equal to the arithmetic average of the original parents and 3.1% higher than the mean reported for the F_2 population. Variation within the first cycle recurrent selection population exceeded that of both original parents and was essentially equal to that of the F_2 population.

The mean lint percentages of the intercross populations varied from 31.2% to 36.6%. None of the intercross populations approached the high lint percentage original parent in mean lint percentage. Most of the intercross populations were more variable than the original parents but it was concluded from examination of the data in this study that a major portion of this variation represented variation among progenies within the populations.

The 76 intercross progenies varied in mean lint percentage from 28.0% to 38.3%. Twelve of the 76 intercross progenies had a mean lint percentage of 36.0% or more and of these 12 highest

lint percentage intercross progenies, only five also had coefficients of variation exceeding that of both parents, indicating some genetic variation.

It was concluded that the basic objectives of recurrent selection, raising the level of expression of a character while maintaining a high degree of genetic variation, were not achieved to a high degree for lint percentage in this study although a moderate degree of improvement was obtained.

In this study, also, a rather strong positive correlation ($r = +0.629$) was found to exist between the mean lint percentage of F_3 parent plants, based on their F_4 progeny performance, and the mean lint percentages of intercross progenies derived from them. Only those intercross parent plant combinations which contained at least one high lint percentage parent plant produced a relatively high frequency of intercross progenies with high mean lint percentage.

INTRODUCTION

In plant breeding the frequency of occurrence of desirable genotypes in a segregating generation is an extremely important consideration and is dependent to a degree upon the breeding procedure adopted. In many cases the plant breeder is limited in the size of population which can be effectively produced and evaluated for a particular character or group of characters. With such cases the frequency of occurrence of superior genotypes, and consequently the method of breeding, are all-important considerations.

The pedigree method of breeding has been used quite extensively in the improvement of self fertilized plants. This method consists of making a cross between selected parents, growing the F_1 and F_2 generations, and subsequently following a system of plant selection and progeny testing within superior lines during the segregating generations until the desired degree of homozygosity is reached.

The number of genes by which the parents differ in respect to a particular character will influence the frequency of occurrence of superior genotypes and consequently the probability of recovering superior genotypes in a segregating generation.

The frequency of recovery of desirable genotypes in an F_2 generation decreases exponentially as the number of genes by which the parents differ increases. In a breeding program therefore where most of the important characters are quantitative in nature of inheritance and governed by a large number of genes, it would be desirable

to employ a method of breeding which leads to a relatively high frequency of occurrence of superior genotypes from which selection can be made.

One such breeding method, recurrent selection, has been utilized extensively in the improvement of inbred lines of corn and in improving combining ability in corn and sweetclover.

The recurrent selection method of breeding consists of making a cross between selected parents and growing the F_1 and F_2 generations. Eight to ten superior F_2 plants are selected on the basis of characters for which selection on an individual plant basis has been shown to be effective. The following year F_3 lines are grown from the selected F_2 plants. The F_3 lines are then crossed in all possible combinations. An intercross progeny is grown from each intercross combination and the identity of each intercross is maintained. Individual plants of the intercross populations are evaluated for desired characters as in the F_2 . Superior plants in the intercross progenies are then selected to begin another cycle of recurrent selection following the same procedure followed in the first cycle. Cycles may be repeated until a desired or final degree of improvement is reached with respect to characters involved.

During recent years the cotton industry has been facing a declining market situation, due in large part to the development of synthetic fibers which have replaced cotton in many processes. These synthetic fibers have proved superior to cotton in several respects, including fiber strength. Many of these synthetics are also cheaper

than cotton in the end product of the manufacturing process. These two superior competitive characteristics of the synthetics have prompted attention within the cotton industry toward improving cotton's position with respect to these properties.

In the past, comparatively little attention has been given to the development of cotton varieties with outstanding fiber strength, particularly in the Southeastern United States. No premium has been offered the grower for high fiber strength cotton; therefore the grower naturally grows varieties which will produce the highest yield per acre. In general cotton breeding has been in the direction of increased yield rather than for improving fiber strength in the Southeastern United States.

In view of these factors it would seem desirable to attempt to combine fiber strength and high yielding ability into varieties which would be adapted to the Southeastern portion of the Cotton Belt.

A considerable amount of evidence has been presented to support the conclusion that lint percentage is an important component of yielding ability. High lint percentage is therefore an important character in that its relationship to yielding ability is also reflected in the unit cost of production, an important consideration for the cotton grower.

It is generally concluded that improvement in the fiber strength characteristic in the Upland cottons of the Southeast must not be made with an accompanying reduction in lint percentage as it

affects yielding ability. The plant breeder is faced however with the fact that there is generally a negative association between fiber strength and lint percentage in cotton.

In the past, there have been three sources of exceptionally high fiber strength available to the cotton breeder. These are: (1) Gossypium hirsutum var. punctatum, or Hopi cotton from the Hopi Indians of Arizona; (2) Gossypium barbadense, particularly the Sea Island and American-Egyptian varieties, and; (3) the tri-species hybrids involving G. arboreum, G. thurberi and G. hirsutum. Unfortunately these sources are generally also low in yielding ability.

The Louisiana Agricultural Experiment Station has initiated a breeding program in an attempt to combine in a single strain or variety the superior fiber strength characteristic of Sea Island, G. barbadense, and high lint percentage and yielding ability of Upland cotton. Deltapine 15, G. hirsutum, is the Upland variety used in this study as the high lint percentage parent.

The recurrent selection method of breeding is being employed as a possible means of concentrating genes for the quantitative characters lint percentage and fiber strength in a single population while maintaining a relatively high degree of genetic variation.

The section of this study relating to fiber strength was reported by Massey (24). The results of the first cycle recurrent selection study involving the behavior of lint percentage are reported in this dissertation.

REVIEW OF LITERATURE

Lint Percentage

McLendon (26) studied the inheritance of lint percentage in a series of crosses involving Upland (G. hirsutum) and Sea Island (G. barbadense) cottons. Crosses between different varieties of Upland cotton were also included in the study.

Results indicated that low lint percentage was dominant to high lint percentage in the F_1 , and in the F_2 generation the original percentages reappeared with variations extending even beyond the extremes of the parents.

Lint percentages reported for the parental varieties involved in the crosses were 27 - 30% for Sea Island and 35 - 38% for Cook's Big Boll (G. hirsutum). Lint percentage in the F_2 generation showed a range of approximately 20 - 50%. He concluded that no ratios could be obtained from these crosses because of the extreme fluctuations in lint percentage.

Leake (20) defined ginning percent as the number of pounds of lint obtained from 100 pounds of seed cotton. He recognized that ginning percent was a complex entity and dependent upon at least four characters: (1) volume of seed; (2) specific gravity of seed; (3) number of fibers arising from a single seed; and, (4) weight of individual fibers. In this study, using 232 samples derived from a wide series of plants of Asiatic cottons and covering a full range of

variation in characters considered; he calculated correlation coefficients for combinations of: (1) ginning percent; (2) number of fibers per seed; (3) weight of 1000 fibers; and, (4) volume of seed.

From these results he concluded there was definite evidence that ginning percent was a complex character. He concluded also that the ultimate causes of variation in ginning percent could not be determined directly but must be sought indirectly through their effect on the three factors under consideration, particularly on the number of fibers per seed.

Meloy (27) pointed out that lint percentage is the relation between the weight of the fiber and the weight of the seeds from which the fiber was obtained in the process of ginning and is expressed as a percentage of the unginned seed cotton. He cautioned that use of lint percentage as a comparative measure of value of varieties could be misleading if used except in connection with lint index.

Thadani (36) studied the inheritance of amount of lint on the seed in crosses involving several American Upland cottons. The variety, No Lint, was involved as a parent in each of four crosses with the varieties Lone Star, Texas Rust, Acala, and Red Leaf. Results relating to inheritance of amount of lint were measured in terms of lint percentage and lint index. Lint percentage of the No Lint parent ranged from 0-10 and the "high lint" upland parents ranged from 26-36.

Ratios obtained in these crosses indicated that a single pair of genes was involved and that "high percentage" was dominant over "low percentage".

Ware (37) studied the inheritance of lint percentage in a series of crosses in which parental material was selected on the basis of varying differences in lint percentage. These crosses involved varieties of G. barbadense and G. hirsutum and were designated A, B, C, and D.

Cross	Female Parent	Male Parent
A	Pima (<u>G. barbadense</u>) X	Winesap (Upland)
B	Pima (<u>G. barbadense</u>) X	Upright (Upland)
C	Sea Island (<u>G. barbadense</u>) X	Winesap (Upland)
D	Texas No Lint (<u>G. hirsutum</u>) X	Normal Lint (Upland)

In the A cross the mean lint percentages of the two parental strains were almost identical. The F_1 and F_2 population means were considerably lower than that of either parental strain. Ware concluded that in cross A low lint percentage was not only dominant but intensified.

In the B cross there was a 7.38 difference between the mean lint percentages of the two parental strains. In this cross also the F_1 mean was lower, but not significantly lower, than the mean of the lower parental strain. He concluded that low lint percentage in this cross was dominant but not intensified.

Mean lint percentages of the parental strains of the C cross were 9.90 apart. The F_1 population mean of this cross was at an intermediate point between the two parental means. He concluded that in this cross high lint percentage was incompletely dominant over low lint percentage.

In the D cross the mean lint percentages of the parental strains were 28.76 apart. The means of both the F_1 and F_2 generations

were at an intergrade point between the parental means but nearer the high % parent than the low % parent. High lint percentage exhibited more complete dominance in this cross than in the C cross.

Ware cited ratios obtained in backcrosses (1:1) and in the F_2 (3:1) as good evidence of single factor control of lint percentage in the D cross. He concluded that information obtained from the D cross might apply to inheritance of lint percentage in general where high lint percentage is dominant or incompletely so. He also stated that the backcross and F_2 ratios indicated that quantitative characters would become qualitative and could be graded provided sufficient extremes in size or degree of difference in percentage could be obtained.

O'Kelly and Hull (29) used Sea Island (G. barbadense) and several strains of G. hirsutum in studies relating to the inheritance of lint percentage. Upland strains used in these interspecific and intra hirsutum crosses were Cleveland (5.1 - 9.4% lint), Half and Half (41.3 - 45.9% lint), Miller (31.7 - 32.7% lint), Okra Leaf (35.0 - 36.9% lint), Trice 78 and 78f (35.0 - 36.0% lint). The Sea Island strain used in these crosses had been inbred for nearly ten years and was considered relatively pure for this character (29.5 - 31.5% lint). Strains of G. hirsutum used in the study also were inbred for a number of years and were considered relatively stable for lint percentage. From a large series of crosses involving this material, the authors concluded that where segregation was sufficiently clear cut to give definite indications, it appeared that lint percentage was controlled by a single pair of genes.

They noted that in crosses between species and in crosses between Upland strains, where the percentage differences of the parents were narrow it was not possible to determine definitely the nature of segregation. Where segregation was definitely evident, they concluded that high percentage was partially or completely dominant.

Ware (38) analyzed further the disagreeing results obtained in the previous study (Ware, 37) of three crosses involving G. hirsutum and G. barbadense.

The relationship of the F_1 generation of each of these three crosses to its parental strains in seed weight and lint index was compared with the relationship of the F_1 generation to its parental strains in lint percentage. This comparison showed that lint percentage was dependent upon both the weight of seeds and the amount of lint per seed. Since lint percentage was determined to be dependent upon two physical parts of the plant the author concluded that lint percentage inheritance could hardly be based upon a single pair of genes. An increase in seed weight due to hybrid vigor, not a decrease in lint yield, was cited by the author as determining low lint percentage in the F_1 of the A and B crosses and an intergrade position of lint percentage in the F_1 of the C cross.

O'Kelly and Hull (29) obtained information relative to correlations between yield of lint, lint percentage, and staple length in parents and progenies using three varieties of Upland cotton, Trice, Miller and Lone Star.

Correlations were obtained from populations representing normal to high yield, normal to high lint percentage, and normal staple length.

Results indicated that parent lint percentage and progeny lint percentage were strongly correlated ($r = 0.474$ to 0.804) with the exception of one variety during one year, the variety Lone Star during 1927 ($r = 0.044$). Abnormal percentages occurring that year and possible ginning errors were cited by the authors as possible explanations for this low value.

Parent lint percentage and progeny yield were positively correlated and the authors suggested that the lint percentage of the parents might be a more dependable prediction of progeny yield than would be parent yield.

Harland (10) defined lint percentage as $\text{lint index} \times 100 \div \text{lint index} + \text{seed weight}$. He considered lint percentage a very complex character, dependent directly upon the weight of the seed and the weight of lint, both of which are complex characters in themselves. He stated also that weight of seed depends on the volume and on specific gravity and that the component factors of lint index are number of hairs per seed and mean hair weight. A further complication of this character according to Harland is the fact that both seed and lint are produced in a boll, the size of which is governed by both genetic and environmental factors.

He cited the observations of O'Kelly and Hull regarding the inheritance of lint percentage in hirsutum-barbadense crosses which stated that inheritance appeared to be monofactorial, with high lint percentage partially or completely dominant, but that the nature of segregation could not be determined definitely in interspecific crosses and in crosses between Upland strains.

Harland concluded that variations in lint percentage occur from day to day on the same plant. He stated that Balls had shown that this was probably due to the changing number of epidermal cells which sprout into hairs.

Kime and Tilley (19) in a study of hybrid vigor in Upland cotton used inbred lines from three Upland varieties (Coker 100, Stoneville, and DPL-11-A) and made crosses in six different combinations. Indications of hybrid vigor were measured in F_1 , F_2 and F_3 generations.

The authors reported that mean lint percentage of the F_1 generations for a two year period was slightly below that of the higher parent but above the average of the parental means. They concluded that partial dominance was indicated in these crosses. A marked reduction in vigor was reported from F_1 to F_3 however which caused a corresponding reduction in lint percentage.

Gonzalez (7) investigated the mode of inheritance and association among seven seed and fiber characteristics in Upland cotton. Characters included lint percentage, boll weight, seed index, staple length, strength of fiber and fuzziness of seed.

Material used in this study included the parents Delfos 9169 (36.8% lint) and (AXB)293 (38.6% lint), and 213 F_2 plants. (The parent (AXB)293 was a selection from the F_4 generation of a cross between the Upland varieties Half and Half x Wilds.)

From this study the author concluded that all of the characters considered, including lint percentage, were quantitative in nature and that each was determined by a large number of genes.

A partial correlation in this study indicated that lint percentage and lint index were associated even though a low simple correlation indicated no association between these two characters. Other correlations of importance in the study included lint percentage and seed index ($r = -0.533$) lint percentage and upper half mean ($r = -0.444$), and lint percentage and fiber strength ($r = -0.048$).

Isaac (13) studied the inheritance of degree of pubescence in Upland cotton and its association with economic characters, including lint percentage. Material used in the study included parental material and the F_2 generation of a cross between Delta Smooth Leaf and Stoneville Composite, both Upland varieties. Due to the fact that the F_2 plants came from open pollinated F_1 plants and the parental plants in the study were representative of, but not progenies of, original plants used in the cross, only general conclusions concerning the genetic nature of the characters were attempted.

The author reported that F_2 results showed that high lint percentage plants were recovered with a high frequency in a relatively small F_2 population. Results indicated also that lint percentage was a quantitative character and that the number of genes by which the parents differed was no more than 3 or 4 major genes.

The author also reported the following correlations involving lint percentage: lint percentage and seed index ($r = 0.333$); lint percentage and upper half mean ($r = -0.352$). Lint strength and lint percentage showed no correlation.

Mason (23) studied the inheritance of lint percentage in the F_1 and F_2 generations of a cross between the Upland varieties Wilds and Half and Half.

Results of this study indicated partial dominance for low lint percentage and relatively simple inheritance with lint percentage expression probably dependent upon three major genes.

A heritability value of 60% for lint percentage was reported for this cross.

Positive correlations were obtained for lint percentage and lint density index, and lint percentage and lint index. A negative association between lint percentage and seed index was reported.

Paliatseas (30) reported results of a study of inheritance of economic characters in a cross involving the Upland varieties Delta Smooth Leaf and Stoneville Composite. An application of the Castle-Wright formula to the F_3 population in this study indicated that the number of genes governing lint percentage was 8.7. In addition a heritability value of $r = 0.77$ was obtained for lint percentage by a regression of F_3 means on F_2 plants. Also, lint percentage was found to be more closely associated with lint density than with lint index and seed index.

Deshotels (4) reported results of studies relating to the inheritance of several economic characters in two crosses involving the Upland varieties Half and Half x Tuxtula and Tuxtula x Delta Smooth Leaf.

Heritability values of 63% and 71% for lint percentage were obtained in the F_2 of these two crosses.

The author noted also that low lint percentage appeared to be partially dominant in these crosses and that lint percentage behaved as a complex character, determined by seed size and lint density. A high

positive correlation between lint percentage and lint density and a negative association between lint percentage and seed index was obtained.

Young (39) stated that, "since lint percentage is a complex of surface area of seed and lint density index, it is probably controlled by the combined number of pairs of genes that determine these characters." From results obtained in a cross between the Upland varieties Delta Smooth Leaf and Hurley Long Boll he determined that lint density index was controlled by 3 pairs of genes and surface area of seed was controlled by 2 or 3 pairs of genes. He concluded, therefore, that as far as lint percentage was concerned, the parents differed by 5 or 6 pairs of genes plus the possible effects of modifiers.

In this study also, Young obtained heritability values for lint percentage of 71% in F_2 and 43% in F_3 . He concluded, therefore, that selection for high lint percentage in the F_2 generation would be effective even though it is a complex character.

Breaux (1) reported an absence of transgressive segregation for lint percentage in a study of the F_3 generation of a cross involving the Upland varieties Wilds and Half and Half. A heritability value for lint percentage of 50.6% was also reported in this study. The author concluded, therefore, that selection for lint percentage on an individual plant basis in F_2 would be effective.

In an F_4 population included in this study Breaux reported a significant positive correlation ($r = 0.324$) between lint percentage and yield of lint cotton.

Limaye (21) studied the inheritance of several economic

characters, including lint percentage, in the F_1 and F_2 generations of three interspecific crosses involving several strains of G. barbadense and G. hirsutum. The following crosses were involved in the study:

- I DPL 15 (1-8) x Sea Island (2-2)
- II DPL 15 (1-15) x Sea Island (3-2)
- III DPL 15 (1-4) x Sea Island (4-2)

Mean lint percentage of the Upland parents ranged from 39.5 to 40.8 with an average of 40.3. The Sea Island parents ranged from 27.8 to 32.3 in mean lint percentage.

From results obtained the author concluded:

(1) Partial dominance for low lint percentage was indicated in the first and third crosses.

(2) Absence of dominance was indicated in the second cross.

(3) Heritability for lint percentage ranged from 95.4% to 95.9%.

(4) It was not possible to determine the number of pairs of genes governing lint percentage.

Ferrer-Monge (6) studied inheritance of lint percentage in 85 F_3 lines from a cross between Upland and Sea Island parents. He reported that both parents were relatively homozygous for lint percentage.

No attempt was made in this study to estimate the number of pairs of genes involved in inheritance of lint percentage. The author reported, however, a heritability value of 77% for lint percentage and suggested that this indicated a desirability of selection on a single plant basis for this character.

He stated also that no line was obtained with lint percentage as high as the DPL 15 parent while a large number of lines were as low or lower in lint percentage than the Sea Island parent.

Shepherd (31) studied the breeding behavior of fiber strength and lint percentage in 95 progenies derived from plants from the first intercross population of an interspecific hybrid involving G. hirsutum, (DPL 15), and G. barbadense, (Sea Island).

The G. hirsutum parent strain in this study had a mean lint percentage of 40.4 and the G. barbadense parent strain had a mean lint percentage of 26.6. The arithmetic average of the parent strains for lint percentage was 33.3.

Means of the 95 lines in this study ranged continuously from 31.7% to 40.5% with an average mean lint percentage for the 95 lines of 37.1%. The author reported that ninety seven percent of the lines in the study had means for lint percentage above the arithmetic average of the parental strains. He noted also that one or more plants occurred in several lines having lint percentages higher than any plant in the high lint parental strain. Transgressive segregation was suggested as a possible explanation for the occurrence of these plants.

The estimate of heritability for lint percentage obtained in this study was comparatively low; however it was noted that high lint percentage plants tended to produce progenies with high lint percentage.

Since a relatively large number of lines occurred with high lint percentage and with considerable genetic variation within the lines,

the author concluded that little difficulty should be encountered selecting a large number of plants with lint percentage equal to or approaching that of the G. hirsutum parent.

The author reported also, however, that a moderately strong negative correlation ($r = -0.51$) existed between lint percentage and fiber strength for the 95 lines. He thus concluded that considerable difficulty might be encountered in obtaining lines with lint percentage equal to that of the G. hirsutum parent and fiber strength equal to that of G. barbadense parent.

Recurrent Selection

Hayes and Garber (11) at the Minnesota Experiment Station in 1915 used certain principles of the recurrent selection procedure in attempting to produce high protein strains of corn from an existing variety, Minnesota No. 14. The objective was to isolate a number of high protein strains and then determine which of these produced the highest yields when crossed.

In this study a number of ears of Minnesota No. 14 were selfed and analyzed for protein content. High protein selfed ears were selected to be used as parents.

Two strains were isolated which gave much higher percentages of protein than the normal pollinated variety. Crosses were made between these two high protein strains and the F_1 crosses were very uniform even though the parental strains had only been selfed for two years.

Bulk analysis showed that the F_1 crosses yielded, on the average, a little over 2% more protein than open pollinated Minnesota No. 13. In addition to an increase in protein content, an increase in yield was also recorded.

From these results the authors concluded that application of these principles offered unlimited opportunity for improving corn.

East and Jones (5) also suggested a breeding procedure which embraced the basic considerations involved in the recurrent selection method. This suggestion evolved from their work relating to genetic studies of protein content of corn.

Basically the procedure involved combining strains obtained by self fertilization and subsequent selection from among the recombinations obtained. The authors felt that this procedure offered a means of increasing protein content and at the same time maintaining heterozygosity.

Jenkins (14) suggested the possibility of producing "synthetic varieties" from among short-time inbred lines for use in instances where production of hybrid corn was not economically feasible. This suggestion was based primarily on the accumulating evidence that inbred lines became relatively stable for yield prepotency early in the inbreeding period. Jenkins felt that this early stability and prepotency would allow corn breeders to use inbred lines in a breeding procedure which would be superior to the various modifications of mass selection in use at that time.

The essential steps of this procedure were outlined as follows:

- (1) Isolate one-generation selfed lines.
- (2) Test these lines in top crosses for yield and other characters to determine their relative endowments with respect to genes affecting these characters.
- (3) Intercross the better endowed selfed lines to produce a "synthetic variety".
- (4) Repeat this process at intervals after each "synthetic variety" has had a generation or two of mixing, including possibly, lines from unrelated sources.

This procedure was envisioned by Jenkins as a more or less continuous one. He stated further that, "a sufficient number of lines should be included in each synthetic strain to permit growers to select seed from it by mass selection during the interval of 3 or 4 years required to complete the next cycle of isolating lines, testing them in hybrids and recombining the selected lines into a new synthetic strain to replace the old one."

Jenkins also concluded that the chance of obtaining outstanding lines was greater through selection from among large numbers of inbred lines rather than from within lines.

Hull (12) first used the term "recurrent selection" in 1945 in work relating to the specific combining ability of corn. He described the breeding plan as consisting essentially of recurrent selection in a crossbred lot of corn for combining ability with a single homozygous line called a tester.

This procedure was outlined as follows:

First Year - Self pollinate 100 or more plants in the crossbred lot and use pollen of each one separately on silks of the tester line. (The 100 plants are selected at random with respect to inherent vigor.)

Second Year - Record yield performances of the 100 test hybrids.

Third Year - Grow ear-rows from selfed seed or 10 or more of the original plants which had the higher yielding test hybrids and make numerous crosses between, but not within, the rows. (Select plants at random for intercrosses.)

One cycle is completed in three years. The next cycle begins with bulked intercrossed seed from the last operation of the preceeding cycle and the same tester line. Cycles may recur continuously.

Hull noted that the tester line should be chosen primarily for general combining ability and that the crossbred lot could be a common variety, a cross of varieties, or a cross of superior inbred lines.

Comstock, Robinson and Harvey (3) proposed a method of breeding which they termed "recurrent reciprocal selection" and which was designed to make maximum use of both general and specific combining ability. The procedure as proposed by the authors was very similar to the procedure followed by Hull (12) with the exception of the fact that "reciprocal recurrent selection" involved two tester lines instead of one.

In the procedure as proposed by the authors, foundation material from two sources would be used, and these sources should be as genetically divergent as possible.

The breeding plan was outlined as follows:

- Year I - Out-cross each of about 200 plants from source A with four or five plants taken at random from source B, and each of about 200 plants from source B with four or five plants from source A. Self pollinate all plants used as pollen parents in these outcrosses.
- Year II - Conduct two field trial comparisons of the progeny of crosses made in first year. The one would involve progenies of source A plants as pollen parent; the other, progenies of source B plants as pollen parent. All seed from each of the four or five crosses involving a single pollen parent would be bulked to produce a single progeny for that parent.
- Year III - Plant seed produced by self fertilization in Year I using seed from only those plants in each of the source groups (A and B) whose progenies were superior in field trials of Year II. Within each source group make all or a large number of the possible single crosses between plants from which seed was planted.
- Years IV, V, VI - Repeat the procedures of Years I, II, and III, using as a starting point the group A and B seed produced in Year III.

From theoretical comparisons the authors concluded that improvement rates expected of this method were superior to selection for general combining ability and the method proposed by Hull. These comparisons indicated to them that under no circumstances would reciprocal recurrent selection be more than slightly inferior to the better of the other two.

Harland (9), faced with the problem of restoring productivity and quality characteristics to Tanguis cotton in Peru, followed a breeding procedure which resembled recurrent selection in several respects. Tanguis had deteriorated as a variety due to contamination and Harland felt that the pure line method could not adequately meet the requirements of a breeding program in which time was a critical factor. He therefore proposed a breeding method which he called "Mass Pedigree Selection." The essential steps as outlined by Harland are:

- (1) To examine a large number of single plant samples from the heterogeneous commercial crop, in order to obtain quantitative estimates of the main characters which are to be worked on, and to establish specifications or norms of the characters required.
- (2) To grow in progeny rows a large number of single plant samples which have passed preliminary tests.
- (3) To examine bulk samples from these progeny rows and to eliminate lines which fail to conform to the norms set up. This may be called the bulked norm test.

- (4) To examine all the single plants of the lines passing this test and to eliminate plants which themselves fail to conform to the norms. This may be called the single plant norm test.
- (5) From this material to select, say, 200 plants. To grow these in progeny rows with an adequate number of replications.
- (6) To apply the bulk norm test to eliminate undesirable lines and also to eliminate lines which in yield of seed cotton per plant are below the mean of the whole population of lines.
- (7) To mix the seed of lines which pass the norm test and to institute a multiplication plot.
- (8) To plant the whole production of No. 7 in an isolated field.
- (9) To plant the whole production of No. 8 on a large area of the same farm.
- (10) To distribute the production of No. 9 as the first commercial wave of seed - approximately 1,000,000 lbs.
- (11) To continue steps 2-10 with such modifications as are necessary so that each year a new wave of seed of approximately 1,000,000 pounds can be distributed.

Through application of this procedure in a breeding program with Tanguis cotton in Peru, Harland reported the following gains:

<u>Character</u>	<u>Old Mean</u>	<u>New Mean</u>
Lint length	19 units	22+ units
Boll weight	4.4	4.7
Ginning %	37.1	40.5
Color -- Inferior strains eliminated.		
Fineness -- Inferior strains eliminated.		
Yield -- Strains below general arithmetic average eliminated.		

Sprague and Brimhall (33) contrasted the relative effectiveness of inbreeding and recurrent selection in increasing oil percentage in corn.

The authors theorized that under a system of inbreeding and selection within inbred lines, a potential ceiling is established at the time of the first selfing determined by the genotype of the plants selected. In addition they felt that a much higher potential ceiling might be established by a process of evaluating a series of individual plants for a given character, truncating the frequency distribution at some desired level, and intercrossing the individuals comprising the truncated tail. This recombination would then serve as source material for a new cycle of selection.

The original material in a study by the authors consisted of reciprocal backcrosses of the single cross Illinois High Oil x wx0s 420. Individual plants were selfed in each backcross population and after harvest were analyzed individually for oil percentage of grain. Five ears saved from each of the two populations were planted ear-to-row the following season and all possible intercrosses among the 10

progenies were made by hand. Equal quantities of seed from each cross were bulked and used as a source for a new cycle of selfing, analyzing and intercrossing.

Standard procedures of selfing and selection within and among inbred lines were continued through five generations in each family as a control.

The mean oil content of the original population was 7.2% and the mean oil content of the parents selected from this population was approximately 8.5%.

The authors reported that the mean of the first cycle of recurrent selection only slightly exceeded the means of the selected parents. Vagaries of sampling was offered as an explanation for this.

The mean oil content of the second cycle population however was 10.5% with an extreme at 13.5%.

Average oil percentage of the inbred lines as a group increased only from 7.0% in S_1 to 7.5% in S_5 .

The authors stated that it was doubtful that further selection and selfing in the inbred lines would increase oil percentage appreciably, whereas, further selection in the recurrent series would be expected to be effective.

They concluded that the recurrent selection procedure at the end of a five year period had been 2.6 times more efficient than selection during inbreeding under conditions of the experiment.

Harlan (8) employed the basic concept of recurrent selection in a study of fixation of types in a highly variable population of

Side Oats Gramma. Although he did not refer to the technique as recurrent selection, it did involve successive cycles of selection, natural intercrossing and reselection.

He reported considerable progress toward fixation of some of the agronomic types in a single generation. Some types bred reasonably true after two generations; other types were less readily fixed.

Lonnquist (22) investigated the recurrent selection method of breeding as a means of increasing the frequency of favorable growth factors in a heterozygous population prior to the extraction of inbred lines, thus increasing the chances of isolating genotypes of superior combining value.

The procedure employed by Lonnquist consisted of recurring cycles of selfing and testcrossing S_0 plants in a heterozygous population. A composite of selfed seed of the highest yielding S_0 plants as determined by their testcross performance was allowed to intercross at random for several generations before initiating the next cycle.

He concluded that the method appeared to provide greater efficiency in the selection of superior genotypes as well as a higher level of combining ability in the lines obtained.

Sprague, Miller and Brimhall (34) studied further the relative effectiveness of recurrent selection and inbreeding in increasing the oil content of corn.

In this study approximately 100 plants of a synthetic variety were self pollinated and the resulting ears analyzed for oil

percentage of the grain. The ten ears having the highest oil percentage were used for both selfing and recurrent selection studies.

In the recurrent selection series the ten ears having the highest oil percentage were grown in ear-row progenies and crosses made by hand in all possible combinations. Equal quantities of seed from each combination were bulked. This was followed by selfing in the bulked increase population. Approximately 100 selfed ears were analyzed individually for oil percentage and the ten ears with the highest percentage were grown in progeny rows and intercrossed as before. Each of these intercrosses was grown as a separate entry in the breeding nursery. Two complete cycles were completed.

In the selfing series the ten foundation ears were grown in progeny rows and approximately half of the resulting plants were selfed. At harvest five of these ears were saved for analysis. The two ears from each family having the highest oil percentage were again planted in progeny rows for further inbreeding and selection. This procedure was continued for five generations of selfing.

An effort was made to keep the intensity of selection for phenotypic characters as similar as possible for the two series.

The authors reported the following results for oil percentage:

Mean oil percentage - original population = 4.2

Mean oil percentage - 1st Cycle Rec. Sel. = 5.2

Mean oil percentage - 2nd Cycle Rec. Sel. = 7.0

Mean oil percentage - 5 generations selfing = 5.6

Range - oil percentage - Original Population 2.5-5.5

Range - oil percentage - 1st Cycle Rec. Sel. 4.0-8.0

Range - oil percentage - 2nd Cycle Rec. Sel. 5.5-9.5

The authors also concluded that in terms of residual genetic variability, recurrent selection was most valuable.

Johnson (16) studied the effectiveness of recurrent selection for general combining ability in sweetclover, Melilotus officinalis.

Parental material was selected from among 1500 spaced plants of the variety Madrid.

The author reported that the mean performance (vigor) of the original population was 91.9% of Madrid and the mean performance of the first cycle was 121.1% of Madrid. He concluded that the large positive gains from a single cycle of recurrent selection indicated that this breeding procedure might be an effective method of breeding forage plants.

In reporting results from the second cycle of recurrent selection in this study, Johnson (16) stated that in both cycles the population means slightly exceeded the means of the 10 plants whose S_1 progenies were used to produce the next cycle. He reported that the open pollinated progeny test mean of the 10 selected Madrid plants was 116%, and the mean of the first cycle population, 121% of Madrid. Also the mean of the 10 plants chosen from the first cycle as parental lines for the second cycle was 146%, and the mean of the second cycle population was 152% of Madrid.

Johnson and Goforth (18) contrasted the effectiveness of controlled mass selection and recurrent selection in a study of general combining ability in sweetclover.

The mean yield of the original population in this study was 91.9% of Madrid and the mean yield of the fourth generation mass selection was 111.2% of Madrid. It was previously shown by Johnson (16) that the mean of the first cycle recurrent selection, based on a progeny test for general combining ability, was 121.1% of Madrid.

From these results the authors concluded that four generations of visual selection for desirable plants by the process of controlled mass selection was not as effective as a single cycle of recurrent selection for combining ability, based on progeny performance.

Jenkins, Robert and Findley (15) studied the effectiveness of the recurrent selection procedure for concentrating genes for resistance to Helminthosporium turcicum leafblight in corn. Nine groups of progenies were included in the study. Each group consisted of a resistant inbred line, a susceptible Corn Belt inbred line, the cross between them, the backcross to the Corn Belt inbred line (or F_2 generation of the cross), and three successive generations of the recurrent selection for leafblight resistance.

The authors reported that in 24 of the 27 comparisons of the effectiveness of the selection procedure, there were positive differences indicating increases in resistance associated with selection. Three comparisons indicated reductions in resistance.

They therefore regarded the selection procedure as highly effective and stated that two cycles of recurrent selection were sufficiently effective in this study to warrant its use in most of the groups considered. They stated further that the necessity for a third cycle of selection would depend upon the degree of improvement accomplished in the first two.

Newman (28) conducted a study to determine the effects of the first cycle of recurrent selection on gene frequency for lint strength and lint percentage in an intra-hirsutum cross. Material in this study included the parents (DPL 14-312 x AHA 6-1-4), the F_1 and F_2 generations of this cross, and the first cycle recurrent population.

The parents used in this study had been selfed several generations and differed widely with respect to both lint percentage and fiber strength. DPL 14-312 had a lint percentage of 39.1 and a fiber strength (Pressley index) of 8.0. AHA 6-1-4 had a lint percentage of 35.0 and a fiber strength of 10.0 (Pressley index). Parental mean for lint percentage was 37.1 and for fiber strength, 9.0 (Pressley index).

The F_2 generation in this study consisted of 1250 plants. Eight of the highest F_2 plants with respect to both lint percentage and fiber strength were selected for the recurrent selection population.

Twenty seven of a possible twenty-eight intercross populations were examined for fiber strength and lint percentage and comparisons of the recurrent selection population were made with 155 randomly selected plants of the original F_2 population. The frequency of plants above the means of the parents was used as a basis for comparison of the two populations.

The author reported that in the F_2 population, 27 plants out of 155, or only 17%, were above the means of the parents in respect to both characters. In the recurrent selection population, 424 plants out of 1223, or 35%, were above the means of the parents with respect to these characters.

The frequency of occurrence of plants above parental means in respect to lint percentage only was reported as 33% for the F_2 population and 88% for the recurrent selection population. The frequency of occurrence of plants above parental means in respect to fiber strength, on the other hand, was reported as 61% for the F_2 population and 39% for the recurrent selection population.

The possibilities of a rather strong partial dominance for high strength in F_2 , environmental effects, and the relatively poor performance of 5 of the 8 F_3 lines for strength were offered as possible explanations for the lower percentage of high strength plant in the recurrent selection population.

From this study the author concluded that selection for both high lint percentage and fiber strength among outstanding plants in the recurrent selection would be more effective than selection among plants in the F_2 population.

McGill and Lonngquist (25) compared three second cycle synthetic varieties of corn, developed by the recurrent selection method, with the open pollinated variety from which they were derived, as sources of new lines.

In this study a group of advanced generation inbred lines developed under a system of continuous selfing in which selection at each generation was based on test cross performance, were compared with S_1 lines from the second cycle synthetics.

The authors reported that shifts in means obtained by recurrent selection were essentially equal to those obtained under a system of continuous selfing where selection from S_1 to S_5 was based on testcross performance.

It was concluded that the recurrent selection procedure was equally as effective as selection within lines as a means of increasing the frequency of favorable genes and it was perhaps superior since it involved a less intensive testing procedure.

Johnson and El Banna (17) reported that progress made by phenotypic recurrent selection for plant vigor and habit of growth in an open pollinated variety of sweetclover suggested the value of the procedure as a rapid and efficient method for improving cross-pollinated forage plants.

Sprague, Russell and Penny (35) reported yield increases of 6.5 bushels and 20.0 bushels following two cycles of recurrent selection in two varieties of corn.

Christie and Kalton (2) evaluated recurrent selection as a means of increasing the range of genetic variability in an available population of Bromegrass, *Bromus inermis*, Leyss., from which more effective selection for seed weight could be made.

On the basis of test crosses for seed weight, the ten highest and the ten lowest clones were selected and recombined in separate polycross blocks.____

Polycross progenies plus propagules of parental clones and two check clones were evaluated for seed weight the following year.

The authors reported that mean seed weights for progeny plants ranged from 0.44 to 1.62 grams per 33 seeds, recombined "high weight" clones ranged from 0.69 to 1.62 grams per 300 seeds, and recombined "low weight" clones ranged from 0.44 to 1.29 grams per 300 seeds.

The authors stated that on the basis of estimated percentages of genotypic variance, it was concluded that further progress by recurrent selection would be feasible.

Massey (24) studied the effect of one cycle of recurrent selection on fiber strength in an interspecific hybrid involving Sea Island (G. barbadense) and Deltapine 15 (G. hirsutum).

Materials included in this study were strains of the parental varieties involved in the original cross, twenty intercross populations of the first cycle of recurrent selection, and F_4 progenies of the 8 F_3 lines which had been selected as intercross parents. The 8 F_3 lines used as parents of the intercross population had been selected on the basis of fiber strength, lint percentage, earliness and boll size.

Massey found that fiber strength classification was consistent for 5 of the 8 F_3 lines based on a comparison of the F_3 lines and their F_4 progenies. He stated that strength classification agreed "in a general way" for the other three lines.

Wide differences were reported among the 8 F_3 lines in their performance as parents in intercrosses. Some lines produced inferior progenies, some produced intermediate progenies, and others produced high strength progenies, in general, in intercrosses.

The author reported the occurrence of several plants in intercross progenies which were abnormally high in fiber strength. The explanation for the occurrence of these plants was uncertain.

Massey stated that there was a marked tendency for all parent combinations to produce a high frequency of intercross progenies

with high mean strength. Fifty-four percent of the intercross progenies tested for higher strength in this study seemed to have potential value for obtaining lines with the high fiber strength of Sea Island through selection. He therefore concluded that selection in the first cycle of recurrent selection was worthwhile and enough genetic variation was present to make further strength improvement by recurrent selection feasible.

Shepherd (31) studied the breeding behavior of fiber strength and lint percentage in 95 progenies derived from plants from the first intercross population of an interspecific hybrid involving G. hirsutum, (DPL 15), and G. barbadense, (Sea Island).

The G. hirsutum parent strain in this study had a mean lint percentage of 40.4 and the G. barbadense parent strain had a mean lint percentage of 26.6. The arithmetic average of the parent strains for lint percentage was 33.3.

Means of the 95 lines in this study ranged continuously from 31.7% to 40.5% with an average mean lint percentage for the 95 lines of 37.1%. The author reported that ninety seven percent of the lines in the study had means for lint percentage above the arithmetic average of parental strains. He noted also that one or more plants occurred in several lines having lint percentages higher than any plant in the high lint parental strain. Transgressive segregation was suggested as a possible explanation for the occurrence of these plants.

The estimate of heritability for lint percentage obtained in this study was comparatively low; however it was noted that high lint percentage plants tended to produce progenies with high lint percentage.

Since a relatively large number of lines occurred with high lint percentage and with considerable genetic variation within the lines, the author concluded that little difficulty should be encountered in selecting a large number of plants with lint percentage equal to or approaching that of the G. hirsutum.

The author reported the following results regarding lint percentage in this study:

- (1) Means of the 95 lines in the study ranged continuously from 31.7% to 40.5% with an average mean lint percentage for all lines 37.1%.
- (2) Four of the 95 lines had means of 40.0% to 40.5% lint percentage, approximately equal to the mean of the high lint percentage parent.
- (3) Thirty lines were slightly below the mean of the high lint percentage parent, (38.0%-39.8%).
- (4) Ninety seven percent of the lines in the study had means above the arithmetic average of the parental strains.
- (5) One or more plants occurred in several lines having lint percentage higher than any plant in the high parental strain. (The author suggested transgressive segregation as a possible explanation for the occurrence of these lines.)

These results indicated to the author that little difficulty would be encountered in selecting a large number of plants with lint

percentage equal to or approaching that of the high lint percentage parent. He also stated that a considerable degree of genetic diversity was exhibited within these lines with respect to lint percentage.

A continuous range also was reported for the means of the 95 lines in fiber strength. The average mean fiber strength of the 95 lines was above the arithmetic mean of the parental strains. For this character also a relatively large number of lines occurred with high fiber strength and having considerable genetic variation. From these results the author concluded that little difficulty should be encountered in selecting a large number of plants with fiber strength equal to or approaching that of the high fiber strength parent.

A moderately strong negative correlation of $r = -0.51$ between lint percentage and fiber strength was reported for this study. It was concluded, therefore, that considerable difficulty might be encountered in obtaining lines with fiber strength equal to the high strength parent and lint percentage equal to the high lint percentage parent. The author suggested, however, that the occurrence of lines moderately high in both characters offered the possibility of obtaining this objective through following cycles of recurrent selection.

Shepherd (32) reported results of the second cycle of recurrent selection in the interspecific hybrid of cotton reported earlier by Massey (24) and Shepherd (31).

On the basis of results reported earlier by Shepherd (31), 12 plants were selected (primarily on the basis of lint percentage and fiber strength) to serve as potential intercross parents in the second

cycle of recurrent selection. Due to poor stand obtained, this number was later reduced to 8 lines to serve as intercross parents. Later 8 plants were selected within each of the 8 lines on the basis of agronomic traits to serve as parental plants within the lines. Crosses were made in all of the 28 possible combinations between lines. These 28 line intercross populations were grown the following year and evaluated on the basis of lint percentage and fiber strength. The author reported that the mean fiber strength of the entire second cycle recurrent selection population was considerably higher than the arithmetic average of the means of the original parents and approached the mean fiber strength of the high strength Sea Island parent. It was pointed out that a high degree of variation which occurred among plants within the Sea Island plot suggested that the influence of environment might account for this high degree of fiber strength that occurred among the line intercross combinations.

The author concluded that these data indicated a good possibility of obtaining, from the second cycle recurrent selection population, a relatively large number of plants with genotypes for fiber strength equal to the high fiber strength Sea Island parent. In addition it was concluded that considerable genetic variation probably occurred among the plants within many of the line and plant intercross combinations having fiber strength means equal to or greater than the Sea Island parental mean.

It was pointed out that due to the negative association which apparently existed between fiber strength and lint percentage,

it was necessary to lower the lint percentage criteria of selected parent plants in order to obtain parent plants with moderately high to high fiber strength.

Shepherd stated that the mean lint percentage of the second cycle recurrent selection population was slightly greater than the arithmetic average of the original parent mean, but considerably less than the mean for the high lint percentage parent, DPL 15. Only one of the 28 line intercross combinations had a mean lint percentage even approaching that of the high parent.

It was concluded generally, however, that line intercross combinations having the highest means for lint percentage were derived from crosses among lines which had relatively high lint percentage means.

In addition, it was pointed out that 79 of the 124 plant intercross combinations contained individual plants having lint percentage indices essentially equal to or greater than the DPL 15 parental mean. Thus it was concluded that it should be possible to obtain a large number of individual plants with lint percentage equal to that of DPL 15 from the second cycle recurrent selection population.

A rather weak significant negative correlation coefficient ($r = -0.260$) was obtained for the entire second cycle recurrent selection population between lint percentage and fiber strength. The author concluded that due to the magnitude of the correlation coefficient, the negative association would not be expected to be a serious handicap in combining high expression of both traits in a breeding program.

The author concluded finally that from the data obtained in this study, a second cycle of recurrent selection was effective in increasing the frequency of occurrence of superior plants with respect to lint percentage and fiber strength.

MATERIALS AND METHODS

The materials used in this study included the Gossypium hirsutum and Gossypium barbadense parents, 39 F_4 progenies derived from 39 F_3 plants which had been selected from 8 F_3 lines used as intercross parents, and progenies of 20 of the 28 possible intercrosses among the 8 F_3 lines. Original parental material involved an interspecific cross between the Deltapine 15 variety of Gossypium hirsutum and the Sea Island strain of Gossypium barbadense.

The original cross between the two species involved in this study was made at Baton Rouge in 1954. A portion of the F_1 seed from this cross was sent to Iguala, Mexico, and grown during the winter of 1954. An F_2 population of 1,391 plants was grown in Baton Rouge during 1955 from selfed seed of the F_1 plants grown in Mexico. These F_2 plants were evaluated for several characters including lint percentage and fiber strength and from these results 51 F_2 plants were selected as source material for the F_3 population.

These procedures had been completed prior to the time that the author became associated with the project.

F_3 lines were grown from the 51 selected F_2 plants in 1956 from open pollinated seed. These F_3 lines were evaluated on a line basis with respect to lint percentage, boll size, earliness, and fiber strength.

On the basis of results obtained from the F_3 lines, 8 lines were selected for use in intercrosses in a recurrent selection study.

Since selection among the 51 F_3 lines was based on four characters, several of the lines were below the mean performance of the parents with respect to one or more of the characters upon which selection was based.

Three of the 8 selected lines were above average in mean lint percentage, two lines were intermediate in mean lint percentage, and 3 lines were below average in mean lint percentage.

In 1957, from remnant open pollinated seed, these eight selected lines were re-planted and numbered 13-20. Eight plants were selected at random within each line and tagged with identifying numbers 1-8. These randomly selected plants were used as parent plants within lines when making the intercrosses between lines.

During the summer of 1957, crosses were made in all possible combinations between the 8 component lines. Bolls of intercrosses made by hand pollination were harvested, put into paper bags marked with identifying plant and line numbers of both parents and ginned separately.

In addition, a 10-20 boll sample of open pollinated seed cotton was harvested from each individual F_3 plant which was involved as a parent in the intercrosses. These samples were also put into paper bags marked with identifying plant numbers and ginned separately.

Lint percentage and fiber strength determinations were made for each of these parent plants and these individual plant data were used in reselecting the intercrossoes to be grown during 1958.

Table 1 presents summary information of the intercross populations and the line-plant combinations involved in each intercross population included in the study. In many cases several plant-line combinations were involved in the same basic line intercrossoes (Table 1).

In this study, for example, individual plants within lines 13 and 15 were crossed in several combinations. The following combinations are noted where crosses involving these two lines occur: 13-1 x 15-3, 13-3 x 15-2, 13-3 x 15-5, 13-5 x 15-2. The population of plants derived from the entire 13 x 15 cross is herein referred to as an "intercross population". The population derived from each individual cross, such as 13-1 x 15-3, is referred to as an "intercross progeny".

The number of F_3 plants in an F_3 line which were involved in the 20 intercross populations ranged from 1 to 5 (Table 1). Three of the 20 intercross populations, 13-1 x 19-1, 16-3 x 17-8, and 20-8 x 17-1, 5 and 8 involved only one plant from one or both of the F_3 lines. Six of the intercross populations involved two plants from one or both of the F_3 lines. Six of the intercross populations involved two plants from one or both of the F_3 lines involved in the intercross. These were intercross populations 13 x 18, 13 x 20, 14 x 18, 15 x 16, 15 x 17 and 17 x 18. Twelve of the intercross populations

Table 1. Intercross populations, parents involved in these populations and number of plants per population in the study.

Intercross population	Plant combinations in intercross population	No. of plants in intercross population
13 x 15	13-1x15-3, 13-3x15-2, 13-3x15-5,	42
13 x 18	13-1x18-1, 13-3x18-1, 13-5x18-7	23
13 x 19	13-1x19-1	13
13 x 20	13-1x20-3, 13-5x20-4, 13-5x20-7	35
14 x 15	14-2x15-2, 14-2x15-4, 14-2x15-5 14-4x15-5, 14-4x15-6, 14-5x15-2	69
14 x 18	14-1x18-1, 14-2x18-1, 14-4x18-1 14-5x18-1, 14-5x18-7	57
14 x 19	14-1x19-1, 14-1x19-2, 14-1x19-3 14-1x19-4, 14-4x19-1	80
15 x 16	15-2x16-7, 15-3x16-5, 15-6x16-5	34
15 x 17	15-3x17-5, 15-5x17-6	14
15 x 18	15-1x18-1, 15-3x18-1, 15-4x18-3 15-6x18-5	42
15 x 19	15-1x19-1, 15-2x19-1, 15-2x19-3 15-3x19-3, 15-3x19-5, 15-5x19-3 15-6x19-7	81
15 x 20	15-2x20-4, 15-3x20-8, 15-4x20-5	29
16 x 17	16-3x17-8	18
16 x 19	16-5x19-1, 16-6x19-1, 16-7x19-5 16-8x19-3	38
17 x 18	17-6x18-7, 17-8x18-5, 17-8x18-7	33
17 x 19	17-1x19-3, 17-5x19-1, 17-5x19-2 17-5x19-3, 17-6x19-5, 17-6x19-7 17-8x19-5	102
17 x 20	17-1x20-8, 17-5x20-8, 17-8x20-8	38

Table 1, Cont'd.

<u>Intercross</u> <u>population</u>	<u>Plant combinations</u> <u>in intercross population</u>	<u>No. of plants in</u> <u>intercross population</u>
18 x 19	18-1x19-1, 18-1x19-3, 18-1x19-5 18-5x19-1, 18-7x19-2, 18-7x19-3 18-7x19-4	70
18 x 20	18-1x20-3, 18-1x20-7, 18-3x20-7 18-5x20-4, 18-7x20-7, 18-8x20-8	83
19 x 20	19-1x20-2, 19-1x20-8, 19-2x20-7 19-3x20-7, 19-4x20-7, 19-4x20-8	104
	Total	1005

involved three plants from one or both of the F_3 parent lines involved in the intercross. These were intercross populations 13 x 15, 13 x 18, 13 x 20, 14 x 15, 14 x 19, 15 x 16, 15 x 18, 15 x 20, 17 x 20, 18 x 19, and 19 x 20. Eight of the intercross populations involved four plants from one or both of the F_3 parent lines involved in the intercross. These were intercross populations 14 x 15, 14 x 18, 14 x 19, 15 x 18, 16 x 19, 17 x 19, 18 x 20 and 19 x 20. Four of the intercross populations involved five plants from one or both of the F_3 lines involved in the intercross. These were intercross populations 15 x 19, 17 x 19, 18 x 19 and 18 x 20.

A total of 83 intercross progenies, composing 1005 plants, was grown and evaluated on the basis of lint percentage in this study. The number of plants which were evaluated within each intercross progeny ranged from 1 to 23. However, only one intercross progeny, 18-1 x 19-5, was composed of one plant. Three intercross progenies, 15-3 x 20-8, 15-6 x 18-5 and 17-1 x 20-8, were composed of only three plants. The remaining seventy nine intercross progenies included five or more plants each which were evaluated for lint percentage.

F_3 lines 15 and 19 were represented in all of the seven possible line intercross combinations. Line 18 was involved in six combinations, lines 17 and 20 were involved in five combinations, line 13 was involved in four combinations, and lines 14 and 16 were involved in three of the seven possible line intercross combinations.

In 1958 the intercross populations outlined in Table 1 were grown at Baton Rouge. Included in this planting also were 10 plots each of the Deltapine 15 and Sea Island parental material and an F_4 progeny from selfed seed of each F_3 plant involved in the intercrosses grown. The parent progenies (Deltapine and Sea Island) were spaced in paired plots at intervals throughout the experimental area in order to obtain an estimate of environmental variation. The Deltapine 15 parent progenies were grown from selfed seed and it is assumed that the Sea Island parent progenies came from open pollinated seed of a plant grown in the greenhouse.

In this dissertation "intercross progeny" refers to a population of plants derived from crossing a single plant of one F_3 line with a single plant of another F_3 line.

The term "intercross population" refers to the population derived from a cross involving two F_3 lines and may include several "intercross progenies."

"First cycle recurrent selection population" refers to the total population of intercrosses involved in the study.

In 1958 an F_4 progeny was grown from each F_3 plant which was involved as a parent of the intercross progenies which were grown and evaluated. Thirty nine F_4 progenies were grown and evaluated on the basis of lint percentage.

The number of plants grown and evaluated in each F_4 progeny ranged from 1 to 24. Two of the F_4 progenies were composed of only one plant per progeny. Thirty two of the F_4 progenies were composed

of 5 or more plants per progeny. A total of 455 F_4 plants were grown and evaluated for lint percentage.

In this study lint percentage was determined by weighing the seed and lint to the nearest one-tenth gram and recording these weights separately. Lint percentage for each sample was then calculated from the following formula:

$$\text{lint percentage} = \frac{\text{wt. of lint (gms.)}}{\text{wt. of seed (gms.)} + \text{wt. of lint (gms.)}} \times 100$$

Lint percentage determinations for all material included in the second cycle recurrent selection population and F_4 progenies were made on a single plant basis.

RESULTS AND DISCUSSION

A basic objective of the cotton breeding program being conducted by the Louisiana Agricultural Experiment Station is to improve the fiber strength of American Upland varieties of cotton while maintaining other desirable agronomic traits of these varieties, particularly high lint percentage.

Results reported in this dissertation relate to the effect of the first cycle of the recurrent selection method of breeding on lint percentage in cotton in an interspecific hybrid involving G. hirsutum x G. barbadense. Results relating to the effect of the first cycle of recurrent selection on fiber strength, which were obtained as a part of this same study, have been previously reported by Massey (24).

The "high lint percentage" parent used in this study was the Deltapine 15 variety of American Upland cotton. The "low lint percentage" parent used was a Sea Island strain of G. barbadense. At the time that this study was conducted Deltapine 15, the high lint percentage parent, was one of the most important varieties being grown in Louisiana.

Recurrent selection has been used as a breeding method in the improvement of inbred lines of corn and in the improvement of several species of forage crops. The recurrent selection method is utilized basically as a means of increasing the frequency of desirable genotypes in a population while maintaining a relatively high degree of genetic variability.

In this study eight F_3 lines which were selected from a cross between Deltapine 15 and Sea Island cotton were crossed in all possible combinations. These F_3 lines were selected on the basis of lint percentage, fiber strength, earliness and boll size. Data relating to lint percentage determinations of the intercross populations of the first cycle of recurrent selection is reported in this dissertation.

Lint Percentage of the Original Parents and Eight
 F_3 Lines Used in Intercrosses

Mean lint percentage data for the parents and eight selected F_3 lines which were used in intercrosses in this study are presented in Table 2. Lint percentage values were determined in 1956 from two 20-boll samples collected at random from plants within each F_3 line.

The original parents differed widely in mean lint percentage. The mean lint percentage of the Deltapine 15 parent when grown in 1956 and 1957 was 42.8%. The mean lint percentage of the Sea Island parent for the same two years was 27.8%. The parents differed in mean lint percentage by 15.0%. The arithmetic average of the two parents was 35.3%.

The eight selected lines do not represent the eight highest lines in lint percentage among the 51 F_3 lines from which selection was made. Selection of these eight lines was based on high fiber strength, earliness, and boll size in addition to high lint percentage.

Table 2. Lint percentage values for the original parents and eight F_3 lines used as parents in intercrosses when grown in two different years.

Parents and F_3 line numbers	Lint Percentage		Mean
	1956	1957	
Deltapine 15	42.5	43.0	42.8
Sea Island	29.2	26.3	27.8
13	34.3	34.9	34.6
14	34.1	34.8	34.6
15	35.9	34.7	35.3
16	39.8	37.2	38.5
17	38.2	35.8	37.0
18	34.2	33.7	34.0
19	37.1	35.6	36.4
20	36.1	35.6	35.9

For this reason several of the lines had mean lint percentages below the arithmetic average of the Deltapine 15 and Sea Island parents.

When grown in 1956 the mean lint percentage of five of the eight F_3 lines was equal to or higher than the arithmetic average of the parents. These were lines 15, 16, 17, 19 and 20. Only lines 16 and 17, however, had lint percentage values exceeding the arithmetic average of the two parents. During 1956 the mean lint percentages of the eight F_3 lines ranged from 34.1% to 39.8%.

When these eight F_3 lines were regrown from remnant seed in 1957 there was relatively close agreement with their performance during 1956. The arithmetic average of the lint percentages of the Deltapine 15 and Sea Island parents during 1957 was 34.7%. In 1957 only line 16 had a mean lint percentage value exceeding the arithmetic average of the two parents by 2% or more. The remaining seven lines had lint percentage values essentially equal to the arithmetic average of the two parents. The mean lint percentages of the eight F_3 lines ranged from 33.7% to 37.2% during 1957.

It should be noted, however, that the lint percentage data in Table 2 for 1956 and 1957 represents measurements from bulk samples collected from all plants within each line. This included both plants which were used in intercrosses and those which were not used in intercrosses.

The means of the 1956 and 1957 lint percentage values varied from 34.0% to 38.5%. On this basis only line 16 had a lint

percentage value exceeding the arithmetic average of the original parents by 2% or more. The remaining seven lines were essentially equal to the arithmetic average of the original parents.

Although relatively good agreement existed in lint percentage values obtained when the eight lines were grown in two different years, relatively poor agreement existed when only the mean lint percentage values of plants actually involved in intercrosses is considered.

Table 3 presents lint percentage determinations for individual F_3 plants within each line which were involved in intercrosses among the eight F_3 lines. From the data in this table line 15 had the highest mean lint percentage among the 8 lines. Four of the six plants in line 15 which were used in intercrosses had lint percentage values which exceeded the arithmetic average of the original parents by 2% or more. One plant, 15-2, had a lint percentage value approaching that of the high lint percentage parent. In line 15, also, one plant, 15-6, had a lint percentage value approaching that of the low lint percentage parent.

Lint percentages of individual plants involved in intercrosses ranged from 41.6% to 29.4%. This range occurred within a single line, line 15, as was noted previously.

Sixteen of the 39 F_3 plants which were involved in intercrosses exceeded the arithmetic average of the lint percentage of the original parents by 2% or more. Four of these plants had lint percentage values of 40% or more which approached the mean lint percentage of the high lint percentage parent.

Table 3. Lint percentage of plants within each of eight lines which were used as intercross parent plants in the first cycle of recurrent selection.

Parental Line Number	Plant Number								Mean
	1	2	3	4	5	6	7	8	
13	33.1		37.7		32.1				34.3
14	34.1	35.2		37.4	36.6				35.8
15	37.4	41.6	39.8	36.2	38.6	29.4			37.2
16			36.6		36.6	31.4	32.8	33.1	34.1
17	36.3				32.8	36.9		38.6	36.2
18	30.4		31.7		35.9		36.8	37.0	34.4
19	35.5	34.2	37.6	31.9	37.6		40.7		36.3
20		36.9	32.6	33.7	40.1		40.5	34.6	36.4

Seven of the 39 F_3 plants which were involved in intercrosses had lint percentage values 2% or more below the arithmetic average of the original parents.

Sixteen of the F_3 plants involved in the intercrosses had lint percentage values essentially equal to the arithmetic average of the original parents.

A basic assumption in the recurrent selection method of breeding is that the performance of a line as such with respect to a given character will be closely associated with its performance in intercrosses. In this study, for example, lines with high lint percentage would tend to produce high lint percentage progenies, lines with average lint percentage would produce progenies with average lint percentage, and lines with low lint percentage would produce progenies with low lint percentage when used in intercrosses.

Based on average performance of the lines during 1956 and 1957 as determined from bulk line samples, only line 16, would be expected to produce relatively high lint percentage progenies when used in intercrosses. The remaining seven lines were intermediate in lint percentage and would be expected to produce intermediate progenies.

Since, however, the F_3 plants within each line which were actually involved in intercrosses were randomly selected and since considerable variation existed in lint percentage values of individual plants within each of the F_3 lines, relatively little value can be placed on line means as a basis of predicting line performance in

intercrosses. Data derived from F_4 progenies of each of the F_3 plants involved in the intercrosses should provide a more reliable estimate of their performance in intercrosses.

The mean lint percentage of each of the F_4 progenies which were derived from F_3 plants involved in intercrosses is presented in Table 4. In this discussion " F_4 progeny" refers to the F_4 plants derived from a single F_3 plant. The term " F_4 population" refers to all F_4 plants derived from various F_3 plants in a particular F_3 line. These F_4 progenies and populations were given the same numerical designation as the F_3 plants and lines from which they were derived. They were grown in 1958 with the original parents and the intercross populations and evaluated for lint percentage.

When grown in 1958 the Deltapine 15 parent had a mean lint percentage value of 40.8%. The Sea Island parent when grown during the same year had a lint percentage value of 27.3%. During 1958 the original parents differed in lint percentage by 13.5%. The arithmetic average of the lint percentage of the original parents during 1958 was 34.1%.

The original intent of the study was that the line would be the basic unit upon which selection would be based. The means of lines did not, however, vary significantly with respect to lint percentage.

In view of the results in Table 4 the mean performance of the lines in intercrosses would not be expected to vary appreciably

Table 4. Mean lint percentage of F_4 progenies grown in 1958 and derived from F_3 plants which were involved in intercrosses.

Parent and F_4 Population	Mean lint percentage of F_4 progeny derived from following F_3 plants								N	Mean
	1	2	3	4	5	6	7	8		
Deltapine 15									59	40.8
Sea Island									52	27.3
13	30.0		36.9		33.8				35	33.9
14	32.8	34.0		35.1	36.8				41	34.7
15	32.3	33.3	37.1	33.3	35.8	33.2			93	34.2
16			36.6		35.6	31.5	33.1	30.9	42	33.5
17	33.8				32.9	35.3		36.3	66	34.8
18	30.3		31.8		32.2		39.1	34.3	34	33.5
19	29.8	33.0	34.1	33.1	35.0		40.1		93	34.2
20		36.2	32.4*	31.3	37.2		33.3*	29.2	51	33.3

*Progeny contained only one plant.

or differ appreciably from the arithmetic average of the original parents. Since, however, significant individual plant difference did occur, considerable differences in mean lint percentage might occur among intercross progenies.

The F_4 populations were composed of a total of 455 plants. The number of plants in each population varied from 34 to 93. The number of plants in each F_4 progeny varied from 1 to 22. Two F_4 progenies, 20-3 and 20-7, contained only one plant each. Five F_4 progenies contained only four plants each and the remaining 32 F_4 progenies contained five or more plants each.

In the following discussion of F_4 populations and progenies the following terminology will be used in referring to lint percentage magnitudes:

High lint percentage - A lint percentage value which exceeds the arithmetic average of the original parents by 2.0% or more.

Low lint percentage - A lint percentage value which is 2.0% or more below the arithmetic average of the original parents.

Intermediate lint percentage - A lint percentage value which lies between 2.0% more than and 2.0% less than the arithmetic average of the original parents.

F_4 population 13 was composed of three F_4 progenies with a total of 35 plants. The mean lint percentage of F_4 population 13 agreed very closely with the mean lint percentage of the three F_3

plants from which the F_4 population was derived. F_4 progeny 13-1 had a low mean lint percentage, F_4 progeny 13-3 had a high mean lint percentage, and F_4 progeny 13-5 was intermediate in mean lint percentage. This agreed in a general way with the relative lint percentages of the individual F_3 plants from which these progenies were derived. Individual plants of F_4 progeny 13-3 ranged in lint percentage from 32.1% to 41.4%. Three plants in this progeny approached or slightly exceeded the mean lint percentage of the Deltapine 15 parent. Individual plants in F_4 progeny 13-1, however, ranged in lint percentage from 24.0% to 34.1%. Seven plants in this progeny approached or were lower than the mean lint percentage of the Sea Island parent. F_4 progeny 13-5 showed considerably less variation in lint percentage among individual plants than the two other progenies in this population.

On the basis of the progeny performance in F_4 , the performance of F_3 line 13 in intercrosses would be expected to be highly variable. Intercross progenies involving F_3 plant 13-3 as a parent would be expected to be relatively high in lint percentage, intercross progenies involving plant 13-5 would be intermediate, and intercross progenies involving plant 13-1 would be low in mean lint percentage.

The mean lint percentage of F_4 population 14 was 34.7%, slightly higher than the arithmetic average of the original parents. This agreed in a general way also with the mean lint percentage of the four F_3 plants from which F_4 population 14 was derived.

A moderate degree of variation existed in the mean lint percentages of the four F_4 progenies of F_4 population 14. F_4 progenies 14-1, 14-2 and 14-4 were intermediate in mean lint percentage and F_4 progeny 14-5 was high in mean lint percentage. F_4 progeny 14-4 was composed of only 4 plants and had a very low degree of variation in lint percentage among individual plants. The remaining three F_4 progenies contained from 11 to 15 plants each and each had a high degree of variation in lint percentage among individual plants within each progeny. F_4 progenies 14-2, 14-4, and 14-5 each contained 2 to 3 plants with lint percentage values near or slightly exceeding the mean lint percentage of the Deltapine 15 parent. Lint percentage values of individual plants within F_4 progeny 14-1 were all near the arithmetic average of the original parents.

On the basis of performance of F_4 progenies, F_3 plants 14-1, 14-2 and 14-4 would be expected to produce intercross progenies with intermediate mean lint percentage and F_3 plant 14-5 would be expected to produce intercross progenies high in mean lint percentage.

F_4 population 15 contained six F_4 progenies and a total of 93 plants. All progenies in F_4 population 15 contained ten or more plants each which were evaluated for lint percentage.

On the basis of mean lint percentage of the six F_3 plants in line 15 which were used in crosses, this line was superior to the other seven lines. On the basis of the mean lint percentage of the F_4 progenies derived from F_3 plants in line 15, however, the line was only average in this respect. Very little agreement existed in the

lint percentage of the F_4 population and the mean lint percentage of the F_3 plants from which it was derived. The lint percentage of F_4 progenies 15-3, 15-4, 15-5 and 15-6 agreed in a general way with the lint percentage of the F_3 plants from which they were derived. There was, however, lack of agreement for F_4 progenies 15-1 and 15-2.

A relatively high degree of variation existed in the lint percentage of individual plants within each of the F_4 progenies of line 15.

On the basis of performance of F_4 progenies, F_3 plants 15-1, 15-2, 15-4, 15-5 and 15-6 would be expected to produce intercross progenies with intermediate mean lint percentage and F_3 plant 15-3 would be expected to produce intercross progenies with high mean lint percentage.

F_4 population 16 contained five F_4 progenies and a total of 42 plants. F_4 progenies 16-3 and 16-7 each contained only four plants. The mean lint percentage of F_4 population 16 was 33.5% which agreed very closely with the mean lint percentage of the five F_3 plants from which they were derived. There was, however, a lack of agreement with the mean lint percentage of line 16 when tested on a line basis during 1956 and 1957. The lack of agreement between the mean lint percentage of the F_4 population of line 16 and the average performance of line 16 during 1956 and 1957 is probably due to the fact that all of the five F_3 plants which were selected as intercross parents in this line were well below the mean of the line in lint percentage.

Relatively good agreement existed, however, between the mean lint percentage of individual F_4 progenies of line 16 and the lint percentage of the F_3 plants from which they were derived.

On the basis of performance of F_4 progenies, F_3 plants 16-6 and 16-8 would be expected to produce intercross progenies with low mean lint percentage, F_3 plants 16-5 and 16-7 would be expected to produce intercross progenies with intermediate mean lint percentage, and F_3 plant 16-3 would be expected to produce intercross progenies with high mean lint percentage.

F_4 population 17 was composed of four F_4 progenies and a total of 66 plants. The number of plants in each F_4 progeny in F_4 population 17 ranged from 13 to 19.

The mean lint percentage of F_4 population 17 was 34.8%, 1.4% lower than the average of the four F_3 plants from which it was derived, and 2.2% lower than the average performance of line 17 during 1956 and 1957.

Relatively good agreement existed between the mean lint percentage of each F_4 progeny in line 17 and the lint percentage of the F_3 plant from which it was derived.

Each of the F_4 progenies in F_4 population 17 which were evaluated for lint percentage contained from 1 to 4 plants which were essentially equal to or slightly higher than the lint percentage of the Deltapine 15 parent.

On the basis of performance of F_4 progenies, F_3 plants 17-1, 17-5 and 17-6 would be expected to produce intercross progenies

intermediate in mean lint percentage and F_3 plant 17-8 would be expected to produce intercross progenies high in mean lint percentage.

F_4 population 18 contained five F_4 progenies and a total of 34 plants. The mean lint percentage of F_4 population 18 was 33.5% which agreed closely with the mean lint percentage of the five F_3 plants from which it was derived and the mean lint percentage of line 18 when evaluated on a line basis during 1956 and 1957.

The mean lint percentages of individual F_4 progenies in F_4 population 18 ranged from 30.3 to 39.1. F_4 progenies 18-1 and 18-3 had low mean lint percentage, F_4 progenies 18-5 and 18-8 had intermediate lint percentages, and F_4 progeny 18-7 had high mean lint percentage, essentially equal to that of the high lint percentage parent. F_4 progeny 18-7 was, however, composed of only four plants.

Due to the low number of plants, 4 to 7, evaluated for lint percentage in four of the five F_4 progenies in F_4 population 18, the reliability of basing predicted performance of this line in intercrosses on these data might be questionable.

Based on the data obtained in F_4 , however, F_3 plants 18-1 and 18-3 would be expected to produce intercross progenies with low mean lint percentage, F_3 plants 18-5 and 18-8 would be expected to produce intercross progenies with intermediate mean lint percentage, and F_3 plant 18-7 would be expected to produce intercross progenies with high mean lint percentage.

F_4 population 19 contained six F_4 progenies and a total of 93 plants. The mean lint percentage of F_4 population 19 was 34.2%,

2.2% lower than the mean of the line during 1956 and 1957 and 2.1% lower than the mean of the six F_3 plants from which it was derived. Mean lint percentage of the F_4 progenies in this population ranged from 29.8% to 40.1%. F_4 progeny 19-1 had a low mean lint percentage, F_4 progenies 19-2, 19-3, 19-4 and 19-5 had intermediate mean lint percentages, and F_4 progeny 19-7 had a high mean lint percentage. F_4 progeny 19-7 had a mean lint percentage approaching that of the Deltapine 15 parent. Lint percentage values for individual plants within F_4 progeny 19-7 ranged from 38.7% to 42.3%.

A high degree of variation in lint percentage of individual plants occurred within each F_4 progeny of F_4 population 19 with the exception of F_4 progeny 19-7.

On the basis of performance of F_4 progenies, F_3 plant 19-1 would be expected to produce intercross progenies low in mean lint percentage, F_3 plants 19-2, 19-3, 19-4 and 19-5 would be expected to produce intercross progenies with intermediate mean lint percentage, and F_3 plant 19-7 would be expected to produce intercross progenies with high mean lint percentage.

F_4 population 20 contained six F_4 progenies and a total of 51 plants. Two of the progenies in this population, 20-3 and 20-7, contained only one plant each which was evaluated for lint percentage. The mean lint percentage of F_4 population 20 was 33.3%, 2.6% lower than the line average during 1956 and 1957 and 3.1% lower than the mean of the F_3 plants from which it was derived. These

differences are probably attributable to the relatively low number of plants contained in four of the six F_4 progenies which comprised F_4 population 20. For this reason, basing predicted performance of F_3 plants in intercrosses on these data might be questionable.

On the basis of available data relating to the performance of F_4 progenies, however, F_3 plant 20-8 would be expected to produce intercross progenies low in mean lint percentage, F_3 plants 20-3, 20-4 and 20-7 would be expected to produce intercross progenies intermediate in lint percentage, and F_3 plants 20-2 and 20-5 would be expected to produce intercross progenies high in mean lint percentage.

Based on progeny performance in F_4 , 9 of the 39 F_3 plants which were involved as parents in intercrosses would be expected to produce intercross progenies with high mean lint percentage, 23 of the 39 F_3 plants would be expected to produce intercross progenies with intermediate mean lint percentage, and 7 of the 39 F_3 plants would be expected to produce intercross progenies with low lint percentage.

On the basis of these data approximately 23% of the intercross parent plants were classified as high in lint percentage. The remaining 77% were classified as either intermediate or low in lint percentage. The effect of the first cycle of recurrent selection would therefore presumably be dependent to some degree upon the relative frequency of occurrence in F_3 plant intercross combinations of the various parent plant classes.

Behavior of the First Cycle Recurrent
Selection Population

A frequency distribution and statistical data for the original parents and the 83 intercross progenies of the first cycle recurrent selection population are presented in Table 5. Intercross populations are designated by the numbers assigned to the F_3 lines involved in the cross and intercross progenies are designated by the F_3 line and plant numbers involved in the intercross. Plants of the parental strains and of each intercross progeny are grouped into class intervals of 2.0 lint percentage units and each class interval is designated by its mean. The estimates of variability that occurred for lint percentage within the parental strains, within the intercross populations, within several of the high lint percentage intercross progenies, and within the first cycle recurrent selection population are presented in table 5 as standard deviations and coefficients of variation.

The 59 plants of the high lint percentage parent, Deltapine 15, ranged in lint percentage from the 38.0% class interval to the 48.0% class interval. Two plants occurred which approached 49.0% which would be extremely high. Since the better sources of high lint percentage available in cotton breeding programs do not approach this level, it is highly probable that the occurrence of these two plants is due to an error in the ginning and weighing of the samples from which lint percentage was calculated.

Table 5. Frequency distribution and statistical data for lint percentage for parents of the original interspecific cross and progenies of 83 plant intercross combinations among 8 selected F_3 lines.

Population	No. of plants in lint percentage classes																No. Plants	Mean	s.d.	C.V. %
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50				
<u>Parents</u>																				
Deltapine 15										8	27	21			1	2	59	40.85	1.92	4.70
Sea Island			4	19	25	1	1	1	1								52	27.29	2.01	7.36
<u>Intercross Progenies</u>																				
<u>Intercross Populations</u>																				
13 x 15																				
13-1 x 15-3							2	5					1				8	34.36		
13-3 x 15-2								1	2	2	2	1					8	37.78	2.80	7.40
13-3 x 15-5							2	3	2	1	1						9	35.02		
13-5 x 15-2		1	3	3	4	3	2			1							17	28.03		
Total		1	3	3	4	3	6	9	4	4	3	2					42	32.59	5.02	15.40
13 x 18																				
13-1 x 18-1			1	3	2		1	2									9	28.61		
13-3 x 18-1						1		2	3	1							7	34.73		
13-5 x 18-7					1	1	1	2		2							7	33.44		
Total			1	3	3	2	2	6	3	3							23	31.94	4.32	13.53

Table 5. Cont'd.

Population	No. of plants in lint percentage classes																Plants	Mean	s.d.	C.V. %
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50				
<u>Intercross Progenies</u>		<u>Intercross Populations</u>																		
		13 x 19																		
13-1 x 19-1				2	2	3		4	1		1						13	31.51		
Total				2	2	3		4	1		1						13	31.51	4.57	14.50
		13 x 20																		
13-1 x 20-3					2	4	3	1	2								12	31.30		
13-5 x 20-4					2	2	3	1	2	1							12	32.98		
13-5 x 20-7				4	1	2	4										11	29.00		
Total				4	5	8	10	2	3	1							35	31.15	3.60	11.56
		14 x 15																		
14-2 x 15-2						2		1	1		1						5	33.84		
14-2 x 15-4						1	6	2	4	1	1						15	33.87		
14-2 x 15-5		1			4	6	4		2								17	30.31		
14-4 x 15-5			1			6	2	1	1								11	31.18		
14-4 x 15-6		1			3	1	3										8	28.99		
14-5 x 15-2						1	3		1	2	4	1			1		13	37.68	5.08	13.48
Total			2	1	7	17	18	4	9	3	6	1			1		69	33.24	1.85	5.56

Table 5. Cont'd.

Population	No. of plants in lint percentage classes																No. Plants	Mean	s.d.	C.V.%	
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50					
<u>Intercross Progenies</u>																					
<u>Intercross Populations</u>																					
14 x 18																					
14-1 x 18-1					1	5	1	2									9	30.87			
14-2 x 18-1					1			2	4	4	5	3					19	35.89			
14-4 x 18-1						1	1	2	1	1	1						7	35.07			
14-5 x 18-1						4	3	3	1								11	32.02			
14-5 x 18-7						1	4		1	5							11	35.01			
Total					2	11	11	11	7	11	4						57	34.08	3.32	9.74	
14 x 19																					
14-1 x 19-1	1				1			6	4	2	1						15	32.65			
14-1 x 19-2				1	4	4	6	1	1	1							18	31.23			
14-1 x 19-3			1		2	3	3	6	3	3						1	22	33.82			
14-1 x 19-4				1		4	1	2	1								9	31.93			
14-4 x 19-1							3	3	5	4	1						16	35.56			
Total	1		1	2	7	11	19	16	12	9	1					1	80	33.15	4.11	12.40	

Table 5. Cont'd.

Population	No. of plants in lint percentage classes																No.	Mean	s.d.	C.V. %	
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	Plants				
<u>Intercross Progenies</u>																					
<u>Intercross Populations</u>																					
15 x 16																					
15-2 x 16-7					1	1	1	2		1							6	32.82			
15-3 x 16-5						1	2	4	7	1	2						17	35.22			
15-6 x 16-5						3	4		4								11	32.83			
Total					1	5	7	6	11	2	2						34	34.02	3.05	8.97	
15 x 17																					
15-3 x 17-5							1	4	1	2							8	34.75			
15-5 x 17-6								2	1	2	1						6	36.65	1.85	3.96	
Total							1	6	2	4	1						14	35.56	2.04	5.74	
15 x 18																					
15-1 x 18-1				2	3	3	2	3	2	1	1						17	31.92			
15-3 x 18-1						2	4	1	1								8	32.44			
15-4 x 18-3			1	1	5	2	2	1	2								14	29.92			
15-6 x 18-5								1				1	1				3	40.40			
Total			1	3	8	7	8	6	5	1	1	1	1				42	31.95	5.45	17.06	

Table 5. Cont'd.

Population	No. of plants in lint percentage classes															No.	Mean	s.d.	C.V. %			
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50				Plants		
<u>Intercross Progenies</u>																						
<u>Intercross Populations</u>																						
15 x 19																						
15-1 x 19-1							4	2	1								7	33.31				
15-2 x 19-1						1	2		1	1							5	33.88				
15-2 x 19-3						3	2	2	4	3	2	1					17	35.49				
15-3 x 19-3						1	1	5	7	3	1						18	35.76				
15-3 x 19-5					1		3	3	7	5	3						22	35.87				
15-5 x 19-3								2	1			1					4	36.83				
15-6 x 19-7						1	1	1	2	2	1						8	35.41				
Total					1	6	13	15	23	14	7	2					81	35.42	2.91 8.22			
15 x 20																						
15-2 x 20-4					1	1	1	3	1	1							8	33.31				
15-3 x 20-8									3								3	36.30				
15-4 x 20-5						1		4	4	6		2	1				18	37.14	3.30 8.87			
Total					1	2	1	7	8	7		2	1				29	36.00	3.48 9.67			

Table 5. Cont'd.

Population	No. of plants in lint percentage classes															No.	Mean	s.d.	C.V. %	
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50				Plants
<u>Intercross Progenies</u>																	<u>Intercross Populations</u>			
																	16 x 17			
16-3 x 17-8							2	1	11	4							18	36.63	2.60	7.10
Total							2	1	11	4							18	36.63	2.60	7.10
																	16 x 19			
16-5 x 19-1					1				2	2	1	1	2				9	36.60	4.57	12.48
16-6 x 19-1					1	2	1	3	1	1							9	32.80		
16-7 x 19-5						2	1	1	5								9	34.32		
16-8 x 19-3					1	2	2	2	1	2	1						11	33.68		
Total					3	6	4	8	9	4	2	2					38	34.32	3.56	10.37
																	17 x 18			
17-6 x 18-7					1			2		2	1	2					8	36.85	4.79	13.01
17-8 x 18-5							1	4	4	4							13	36.00	1.97	5.46
17-8 x 18-7						2	1	4	2	2							12	35.49		
Total					1	2	2	10	6	8	1	2					33	36.02	3.90	10.82

Table 5. Cont'd.

Population	No. of plants in lint percentage classes																No. Plants	Mean	s.d.	C.V. %	
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50					
<u>Intercross Progenies</u>																					
<u>Intercross Populations</u>																					
17 x 19																					
17-1 x 19-3								5	3	1							9	35.43			
17-5 x 19-1			1	2	2	5	7	1									18	32.24			
17-5 x 19-2			1		1	2	2	3	1	1							11	34.14			
17-5 x 19-3					3	5	1	1	3		1						14	34.01			
17-6 x 19-5					1	2	4	3	2	2							14	35.42			
17-6 x 19-7						5		4	5	2	3	2					21	37.36	3.82	10.21	
17-8 x 19-5						1	1	2	5	3	3						15	38.31	2.93	7.65	
Total				2	2	7	20	20	17	17	8	7	2				102	35.35	3.75	10.61	
17 x 20																					
17-1 x 20-8								3									3	33.90			
17-5 x 20-8				1	8	7	4										20	31.53			
17-8 x 20-8				1		2	3	6	2	1							15	35.03			
Total				2	8	9	10	6	2	1							38	33.10	2.69	8.13	

Table 5. Cont'd.

Population	No. of plants in lint percentage classes															No.	Mean	s.d.	C.V. %	
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50				Plants
<u>Intercross Progenies</u>		<u>Intercross Populations</u>																		
		18 x 19																		
18-1 x 19-1					1	2	7	2	2								14	31.94		
18-1 x 19-3			1		1	2	2	1		1							8	32.08		
18-1 x 19-5												1					1	39.20		
18-5 x 19-1					1	1	3	4	5	2	2						19	35.08		
18-7 x 19-2							2	4		3	2						11	35.78		
18-7 x 19-3							1	1		2	1	1					6	37.20	3.46 9.29	
18-7 x 19-4					1		4	4	1	1							11	33.44		
Total				1	4	5	19	16	8	9	6	1					70	32.59	7.69 23.60	
		18 x 20																		
18-1 x 20-3		1	1			1	5	1	1	1	1						12	30.32		
18-1 x 20-7							1	2	8	3	2						16	34.60		
18-3 x 20-7			1		2	2	4	1			2						12	31.66		
18-5 x 20-4					1	3	1			2	4	1					12	34.50		
18-7 x 20-7						1	1			4	2	1					8	36.65	2.56 6.98	
18-8 x 20-8					1	1	7	8	1	3	2						23	34.06		
Total		1	1	1	5	12	15	18	11	14	4						83	33.59	3.71 11.04	

Table 5. Cont'd.

Population	No. of plants in lint percentage classes																No.	Mean	s.d.	C.V. %
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	Plants			
<u>Intercross Progenies</u>																	<u>Intercross Populations</u>			
19 x 20																				
19-1 x 20-2					1	1	8	4	5		1						20	33.65		
19-1 x 20-8				1		1	7	1									10	31.47		
19-2 x 20-7							3	5	1	2	1		1				13	35.42		
19-3 x 20-7						4	3	2	5	6	1	2					23	35.52		
19-4 x 20-7					2	4	3	2	5		1						17	33.05		
19-4 x 20-8	1				1	6	4	3	4	2							21	32.37		
Total		1		1	4	16	28	17	20	10	4	2	1				104	33.73	3.42	10.10
Grand Total																	1005	33.82	4.17	12.33

A coefficient of variation of 4.7% was found in this study for the Deltapine 15 parent. This low coefficient of variation agrees generally with the 1.6% found by Limaye (21), and the 2.3% found by Ferrer-Monge (6), in studies relating to the F_2 and F_3 populations of the original cross involved in this study. This also agrees rather closely with the 3.6% reported by Shepherd (31) for this parent when grown during 1960. The low coefficient of variation for lint percentage for this parent probably indicates a homozygous condition for lint percentage and that the influence of environment on expression of lint percentage was low.

The 52 plants of the low lint percentage parent, Sea Island, ranged in lint percentage from the 24.0% class interval to the 36.0% class interval. The coefficient of variation for the Sea Island parent in this study was 7.36%, slightly higher than the 3.53% reported by Limaye (21) and the 4.4% reported by Ferrer-Monge (6), but essentially equal to the 7.8% reported by Shepherd (31) in studies involving this Sea Island strain during 1960. The higher coefficient of variation for this parent indicates the possibility of the occurrence of some genetic variation within this strain or that the influence of environment was greater than that noted for the Deltapine 15 parent.

The mean lint percentages reported for the Deltapine 15 parent (40.9%) and the Sea Island parent (27.3%) agree very closely with means reported previously by Limaye (21) and Shepherd (31) working with these same parental strains.

When grown during 1958 in this study the original parents differed in mean lint percentage by 13.56%. The arithmetic average of the parents for lint percentage was 34.07%.

The mean lint percentage of the entire first cycle recurrent selection, (Table 5) was 33.82%, which was essentially equal to the arithmetic average of the mean lint percentages of the original parents (34.07%). Limaye reported a mean lint percentage of 30.7% for the F_2 population from this same original cross. The mean lint percentage of the first cycle recurrent selection population therefore exceeded the reported mean lint percentage of the F_2 population by 3.1%.

The coefficient of variation for the first cycle recurrent selection population (Table 5) was 12.3%, which was only slightly below the 13.3% reported by Limaye for the F_2 population.

Eighteen of the 20 intercross populations in the study were composed of two or more intercross progenies and the mean lint percentages of these 18 populations ranged from 31.15% to 36.02%. On the basis of mean lint percentage, therefore, the intercross populations did not vary appreciably from the arithmetic average of the mean lint percentages of the original parents and apparently none was definitely superior in concentration of genes for high lint percentage. Only two intercross populations had a mean lint percentage exceeding that of the arithmetic average of the original parents by approximately 2.0% and none of the intercross populations had a mean lint percentage value approaching that of the high lint percentage parent. Eight of the eighteen intercross populations in this study which contained two or more intercross progenies exceeded the mean lint percentage of F_2 by 3.0% or more.

Coefficients of variation of the intercross populations ranged from 5.56% to 23.60%. Only four of the 18 intercross populations with two or more intercross progenies had a coefficient of variation equal to or exceeding that reported for the F_2 by Limaye. None of the eight intercross populations which were highest in mean lint percentage had a coefficient of variation equal to that of the F_2 .

Although many of the intercross populations had coefficients of variation higher than that of both original parents, it is evident that a considerable portion of the variation reported for the intercross populations is due to variation among the progenies which comprise the populations.

It was assumed earlier that, since the F_3 lines involved as intercross parents in this study did not differ significantly in mean lint percentage, their mean performance in intercross populations would not vary appreciably. It was assumed further that, since the F_3 plants within lines did vary considerably in lint percentage, their mean performance in intercross progenies would differ.

The mean lint percentage of the 76 intercross progenies (Table 5), which contained six or more plants each, ranged from 28.03% to 38.31%. Only 12 of these intercross progenies had a mean lint percentage of 36.0% or more. The coefficients of variation of these 12 highest lint percentage intercross progenies (Table 5)

ranged from 3.96% to 13.48%. Only 5 of the 12 intercross progenies which were highest in lint percentage had a coefficient of variation of 8.0% or more, indicating some genetic variability.

It can be concluded, therefore, from the data in table 5 that relatively few of the intercross progenies in this study fulfilled to a reasonable degree the basic expectations of recurrent selection: to increase the level of expression of the character involved while maintaining a high degree of heterozygosity.

Several explanations might be offered for the low relative effectiveness of the first cycle of recurrent selection for lint percentage in this study.

As has been explained previously, the F_3 lines which were selected as intercross parent lines in the study were selected on the basis of four characters: lint percentage, fiber strength, boll size and earliness. As a result, only two of the selected lines approached the high lint percentage parent in mean lint percentage. Eight F_3 plants were selected at random within each F_3 line to serve as intercross parent plants. F_4 progenies were grown from each of these F_3 parent plants and from these data only one F_4 progeny (19-7), with six or more plants, was equal in mean lint percentage to the high lint percentage parent. This F_3 plant was involved as a parent in only two of the intercross progenies evaluated. Only three of the F_4 progenies with six or more plants had a mean lint percentage of 37.0% or more. None of the intercross

progenies in the study were derived from crosses among any two of these three apparently superior F_3 plants. The low number of apparently superior F_3 parent plants involved in the intercrosses probably exerted considerable influence on the low frequency of occurrence of intercross progenies which were superior in mean lint percentage.

Recent studies, (31) and (32), relating to a material derived from this study indicated a moderately high negative association between lint percentage and fiber strength. It was suggested that since selection was practiced originally for high fiber strength and high lint percentage, this might have resulted in the selection of a number of plants where linkage between high fiber strength and low lint percentage existed. This explanation might also account for a portion of the relatively inferior results from the first cycle of recurrent selection.

Limaye (21) reported from studies of the F_1 and F_2 of the material involved in this study that the components of lint percentage acted in such a way that low lint percentage became dominant. He reported that large seed size was dominant in the F_1 and F_2 generations and that seed index and lint percentage were negatively associated.

Since the intercross progenies of this study represent F_1 populations, it is possible that seed index might have been influenced by hybrid vigor in such a manner that low lint percentage became dominant as was the case in the F_1 and F_2 of the original cross.

In addition, the possibility exists that the recurrent selection method of breeding may be relatively ineffective in increasing the level of expression of lint percentage in populations of the nature included in this study, while at the same time maintaining a high degree of heterozygosity.

It is possible also that all of the explanations offered above may have exerted varying degrees of influence upon lint percentage in the first cycle recurrent selection population.

Behavior of F_3 Parent Plant Combinations in Intercrosses

It was assumed earlier in this study that F_3 parent plants with a high lint percentage, based on F_4 progeny tests, would tend to produce intercross progenies with relatively high mean lint percentage. In addition it was assumed that F_3 parent plants which were relatively inferior in lint percentage based on an F_4 progeny test would tend to produce intercross progenies with relatively low lint percentages. It is of interest and value, therefore, to test the validity of this assumption and to determine the general relationship between the lint percentage of F_3 parent plants and their behavior in intercross progenies.

One method of determining this relationship is to determine the correlation of the mean lint percentage of the progenies from F_3 parent plants with the mean lint percentage of the intercross progenies derived from them. For purposes of determining this correlation in the study, only those intercross progenies which contained six or more plants were included.

In this study a correlation coefficient of $r = +0.629$ was found indicating a rather strong positive association between the mean lint percentage of the F_3 parental plants, as determined from F_4 progeny tests, and the mean lint percentage of the intercross progenies derived from them.

On the basis of the correlation, therefore, it can be concluded that F_3 parental plant combinations with high mean lint percentage tended to produce intercross progenies with high mean lint percentage and F_3 parental plant combinations with low mean lint percentage tended to produce intercross progenies with low mean lint percentage.

In addition to the general information provided by the correlation it should be of interest to determine the relative frequency with which the various parental lint percentage combinations tended to produce intercross progenies in a particular lint percentage classification.

For purpose of these determinations the F_3 parental plants were classified from the mean lint percentage of F_4 progenies as high, intermediate and low in mean lint percentage. Only those F_3 plants which had an F_4 progeny with 4 or more plants were included in these classifications. In addition, the intercross progenies which had 6 or more plants were classified as high, intermediate and low in mean lint percentage according to the same lint percentage magnitudes which were used in classifying the F_3 parent plants.

In this study a correlation coefficient of $r = +0.629$ was found indicating a rather strong positive association between the mean lint percentage of the F_3 parental plants, as determined from F_4 progeny tests, and the mean lint percentage of the intercross progenies derived from them.

On the basis of the correlation, therefore, it can be concluded that F_3 parental plant combinations with high mean lint percentage tended to produce intercross progenies with high mean lint percentage and F_3 parental plant combinations with low mean lint percentage tended to produce intercross progenies with low mean lint percentage.

In addition to the general information provided by the correlation it should be of interest to determine the relative frequency with which the various parental lint percentage combinations tended to produce intercross progenies in a particular lint percentage classification.

For purpose of these determinations the F_3 parental plants were classified from the mean lint percentage of F_4 progenies as high, intermediate and low in mean lint percentage. Only those F_3 plants which had an F_4 progeny with 4 or more plants were included in these classifications. In addition, the intercross progenies which had 6 or more plants were classified as high, intermediate and low in mean lint percentage according to the same lint percentage magnitudes which were used in classifying the F_3 parent plants.

It should be noted that the terms high, intermediate and low are used here in a relative sense and only for comparative purposes.

The division of the parent plants into the three categories mentioned above resulted in six possible intercross combinations. These combinations are high x high, high x intermediate, high x low, intermediate x intermediate, intermediate x low and low x low.

Results of this classification procedure are presented in Table 6.

A total of 67 intercross progenies were classified on the basis of mean lint percentage and without regard to line or intercross population number into the three categories, high intermediate and low.

A significant feature of the classification in table 6 is that of the 26 intercross progenies derived from crosses involving at least one high lint percentage parent plant, 9 were classified as high in mean lint percentage. In addition, no low lint percentage intercross progenies occurred where at least one of the intercross parent plants was classified as high in lint percentage.

Of the 41 intercross progenies which contained no high lint percentage intercross parent plants, only two were classified as high in mean lint percentage and 13 were classified as low in mean lint percentage. No intercross progenies with high mean lint percentage occurred where both intercross parent plants were classified as low in lint percentage.

Table 6. Relation between the lint percentage of F_3 parental plant combinations and mean lint percentage of inter-cross progenies derived from them.

Lint percentage classification of F_3 parent plants	No. progenies in lint percentage classes*			
	H	I	L	Total
H x H	1	2		3
H x I	5	9		14
H x L	3	6		9
I x I	1	11	5	17
I x L	1	14	4	19
L x L		1	4	5
Total	11	43	13	67

*H = high lint percentage, mean 36.0% or above

I = intermediate lint percentage, mean 32.0% to 35.9%

L = low lint percentage, mean 31.9% or below

These data would be of value in the breeding program since they indicate that on the basis of a progeny test for lint percentage of F_3 parent plants, certain F_3 plant intercross combinations could be safely discarded. These data indicate that only those F_3 parent plant combinations which contained at least one high lint percentage parent plant produced a reasonably high frequency of high lint percentage intercross progenies.

SUMMARY AND CONCLUSIONS

1. This study was conducted to determine the effect of the first cycle of recurrent selection on lint percentage in an interspecific hybrid of cotton. The original parents involved in the study were strains of Deltapine 15, Gossypium hirsutum, and Sea Island, Gossypium barbadense.

2. The F_2 population was evaluated on the basis of lint percentage, fiber strength, boll size and earliness. From these data, 51 F_2 plants were selected and progeny tested in F_3 on the basis of these 4 characters.

3. From the results of data obtained in F_3 , eight lines, each apparently superior in respect to one or more of these 4 characters were regrown from remnant seed and intercrosses were attempted in all possible combinations. Eight selected F_3 plants within each F_3 line were used as intercross parent plants within lines.

4. The original parents, F_4 progenies of the F_3 intercross parent plants, and 83 intercross progenies representing 20 of the 28 possible line intercross populations were grown and evaluated for lint percentage. All lint percentage evaluations were made on a single plant basis.

5. A relatively low degree of variation existed among the F_3 lines in mean lint percentage. On the basis of bulk samples

of seed cotton from the F_3 lines during two years, only one of the eight selected lines exceeded the mean lint percentage of the original parents by more than 2.0%. The remaining 7 lines were essentially equal to the arithmetic average of the original parents in lint percentage.

6. Based on F_4 progeny evaluations for lint percentage, the F_3 plants within lines used as intercross parent plants did vary considerably in mean lint percentage.

7. In this study the term "intercross population" was used to refer to the hybrid plants derived from crosses between two F_3 lines and the term "intercross progeny" was used to refer to the hybrid plants derived from crosses between two particular F_3 plants.

8. The mean lint percentage of the entire first cycle recurrent selection population was 33.82%, essentially equal to the arithmetic average of the mean lint percentages of the original parents (34.07%) and 3.1% higher than the mean lint percentage of the F_2 population. The coefficient of variation of the first cycle recurrent selection population was 12.3%, higher than that of both original parents and only slightly lower than the 13.3% reported for the F_2 population.

9. The mean lint percentages of the intercross populations did not vary appreciably nor did they differ appreciably from the mean lint percentage of the original parents. Apparently none of the intercross populations were definitely superior in the concentration of genes for high lint percentage.

10. The coefficients of variation of the intercross populations varied considerably and in most cases exceeded that of both of the original parents. It was concluded, however, that variation among intercross progenies within the intercross populations accounted for a major portion of this variation.

11. None of the intercross progenies which contained six or more individual plants were equal in mean lint percentage to the high lint percentage parent, Deltapine 15. Only 12 of the 76 intercross progenies which contained six or more plants each, had a mean lint percentage of 36.0% or more.

12. Only 5 of the 12 intercross progenies which were classified as highest in mean lint percentage also had coefficients of variation exceeding that of both original parents indicating some genetic variability.

13. A rather strong positive association ($r = +0.629$) was found to exist between the mean lint percentage of F_3 parent plants involved in intercrosses, based on their progeny performance in F_4 , and the mean lint percentages of intercross progenies derived from them.

14. A relatively high frequency of high lint percentage progenies was derived only from those F_3 parent plant intercross combinations which included at least one high lint percentage parent plant.

15. On the basis of data obtained in this study, the first cycle of recurrent selection did not apparently fulfill to

a high degree the basic expectations for lint percentage: the concentration of genes for high lint percentage in the population while maintaining a high degree of genetic variation.

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AUTOBIOGRAPHY

Warren Allen Meadows, the son of Sidney B. and Bessie F. Meadows, was born at Lettsworth, Louisiana, on August 17, 1930.

He attended the public schools of Pointe Coupee Parish and graduated from Innis High School in 1947.

He attended the University of Southwestern Louisiana from 1947 to 1949 and transferred to Louisiana State University in September, 1949.

In September, 1950, he entered the U.S. Navy and served four years as an aerial photographer during the Korean War.

Following discharge from the U.S. Navy he returned to Louisiana State University and received his Bachelor of Science degree in Agriculture in August, 1955.

In September, 1955, he entered the Graduate School at Louisiana State University, where he received his Master of Science degree in the Department of Horticulture in August, 1956.

He has been employed by the Louisiana Agricultural Extension Service as a Specialist in Horticulture since October, 1958.

In 1966 he was granted sabbatical leave to complete requirements for the Ph.D. degree in the Graduate School at Louisiana State University. He is now a candidate for the degree of Doctor of Philosophy in the Department of Agronomy.

EXAMINATION AND THESIS REPORT

Candidate: Warren Allen Meadows

Major Field: Agronomy

Title of Thesis: The Effect of Recurrent Selection on Lint Percentage in an Interspecific Hybrid of Cotton

Approved:

M. T. Henderson
Major Professor and Chairman

Max Goodrich
Dean of the Graduate School

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Date of Examination: July 18, 1967